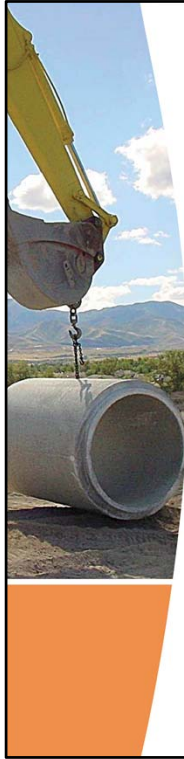


Trust but Verify “Post Installation Inspection (PII) of Storm Pipe”





Today's Discussion Topics

- Overview & Importance of this Topic
- PII - Tools and Techniques
- PII - National Standards & Current Trends
- Practical Considerations for Implementation
- Resources & Additional Training

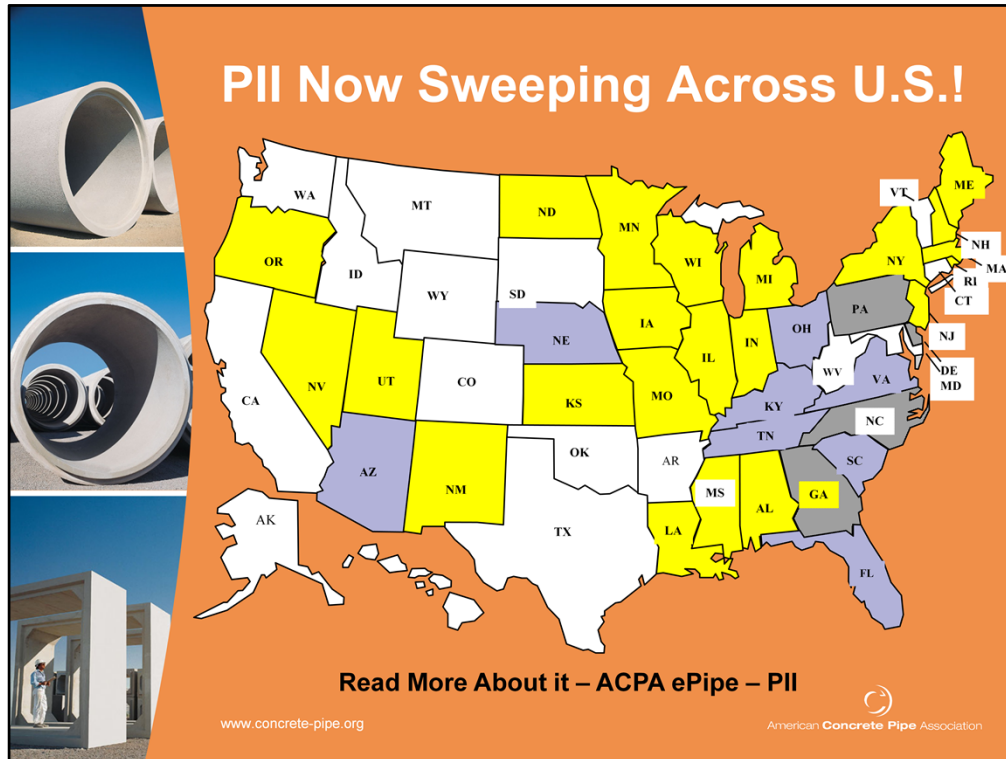
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Post Installation is a relevant and timely subject with respect to newly installed storm piping systems as well as evaluation of existing piping assets.

Today we will discuss the

- Tools and techniques used for PII Data Collection,
- Look into what the National Standards have to say about PII
- Share some of our experience with you so Implementation of PII can be completed without a long learning curve being involved
- and Introduce you to resources and additional training opportunities we can provide with respect to PII



It is important that owners, consultants, installers understand that required inspection of newly installed pipe systems is becoming more and more common across the U.S, Canada, and around the world. Also it is worthy of note that many system owners are taking more interest in the current state of aged and existing pipe lines in their systems.

Some fact and figures that might interest you are

- currently 2 of 3 of State DOT's Require some level of PII of their newly installed pipe
- 1 of 4 allow or require Advanced Inspection Tools
- If your interested to learn more about the trends and current state of PII please go to the ACPA – see ePipe - “Video and Laser Measurement Tools” Inspection

Map KEY

- States shown in solid yellow have mandatory deflection inspection requirements.
- States shown in dashed blue, require or allow the use of laser profiling technology for post-installation inspection.



Why the Growth of PII ?

- **Required by AASHTO**
- **OWNER** assumes a **Trust but Verify** Position
- **Contractor/Installer** - Improved Quality of installations
- **Producer/Supplier** – Product **Handled and Installed Properly**
- **System User** – **Safety Risk** Minimized and No Fear of **Unanticipated Future Costs**
- **Tax-Payers** - **Minimizes Lifetime Project Cost!**

Slide 4

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PII is gaining popularity with Owners, Specifiers, and Consultants for a multitude of reasons:

- Provides **Quality Assurance** of the **Completed Installation** – Confirms Installation is of **highest Quality** and no significant damage has occurred during construction that would diminish system structural integrity, service life, or proper operation of the pipeline.
- The use and application of Post Installation Inspection Has Greatly **Reduced Risk** for future **unanticipated Maintenance or Replacement** and will improve the overall level of installation across the system.
- Owners will be in a position to fully protect their investments made In the infrastructure and by doing so will reduce the overall lifetime project costs!

PII - Tools and Techniques -

- Document Conditions
- PII Inspection Methods
- Advanced Tools



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• **There are several acceptable PII Inspection Methods;**

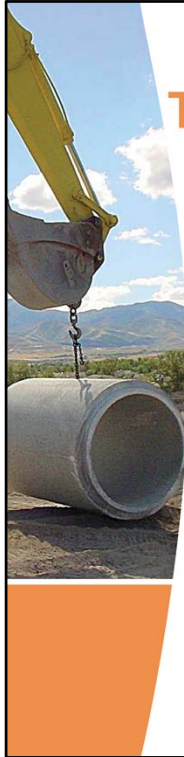
- Where man-way access is safe –usually in Larger Diameters say 42” and larger - Visual Inspection methods are acceptable and useful.
- In Small Diameter pipe inspections are normally conducted with some type of remote access tool – The CCTV (lower rt picture is typical set up for CCTV inspection of small Dia. Pipe) is currently the most commonly used method of remote inspection of small diameter pipe systems.

• **The goal of all PII inspections are to Document the Condition of the pipeline being inspected to check for construction damage, design errors, or signs of poor installation procedures...Each and every issue of concern should be documented and located so the severity of the issue can be determined.**

• **There are several Add on or additional inspection Tools that can help to properly measure and or document issues one might find in the installed pipe:**

- Laser Profiler systems are used to confirm wall shape in flexible pipe (these products can be used to confirm amount of deflection, ovality, loss of flow capacity etc...)
- Laser Micrometers can also be used in conjunction with CCTV to measure issues found on the inside of the wall surface...joint openings, holes, crack length and width etc...
- We will discuss the application of these add on tools in the following slides...

Tools of the TRADE



CCTV – Camera

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Picture on the left is a picture of a typical CCTV camera – set up for inspection of up to 48" in diameter (large wheels, and camera can be elevated to approximate mid-point/center of pipe for accurate investigation)

The Camera system on the right is a typical set up for small diameter pipe lines (4" – 12" – Small wheels, very compact set up to allow entry into small diameter pipe...sanitary sewer applications, pavement underdrains, etc...)



In addition to the CCTV camera there are other add-on inspection tools or other tools that must be used to check for deformation/deflection of flexible pipe.




The top two pictures are indicative of laser profiler system that projects a laser light (See hardware that projects laser light ring and see the red line in the picture as the image is captured in video format) onto the wall of the pipe and software is used to obtain accurate measurements of the projected laser image so the deflection/deflection of the internal shape of the pipe can be determined.

Mandrels can also be utilized to check for over deflection of flexible pipe systems. Typically the mandrel is constructed to be slightly less than the actual internal diameter of the subject pipe (We typically see mandrels utilized that are constructed at 95% of actual internal diameter of pipe being inspected).

The mandrel is a go-no –go Test...if mandrel cannot pass through pipe the pipeline fails...however the mandrel only tells the story in one spot and certainly should not be the only inspection method for a flexible pipe...the CCTV should also be combined with the mandrel for flexible pipe inspections or the CCTV should be combined with the Laser profiler add-on to confirm pipe shape control. Many specifications we see allow the use of either the Mandrel or the laser profiler.


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Measurement - Tools Cont...

Video Micrometer

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Most current CCTV video cameras are equipped with Video Micrometer tools that allow for small anomalies inside the pipe to be measured.

The tools are useful to insure joint tolerances are met, measure cracks, Splits, or tears in pipe walls.

The information provided by these tools are critical in the proper evaluation of the severity of issues presented on the inside wall of the pipe line being inspected.

It is worth noting that very fine measurements of less than 0.05" (thickness of a dime) are very difficult if even possible in the storm sewer or sanitary sewer environment. To learn more about the actual accuracy of these devices you can see ACPA ePipe – "What is the Practical Accuracy of Crack Measurement in Concrete Pipe"

Please note that the video micrometer is an excellent and needed inspection tool, however we simply want you to be aware that trying to use these tools to accurately measure very small and insignificant issues on the wall of the pipe will not provide accurate and repeatable evaluation information.




Post Installation Inspection – National Standards

AASHTO – “LRFD Bridge Construction Specifications”

- **CMP – Section 26.5.7**
- **RCP – Section 27.6.1**
- **THERMOPLASTICS –
Section 30.5.6**

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In 2005 the AASHTO – DOT community insisted that PII guidelines be established for each of the major pipe types and be added to the AASHTO LRFD Bridge Construction Specifications.

After much work by the AASHTO committee members and comments from Pipe organizations The AASHTO Installation specifications listed above now include Post Installation Inspection requirements for the three major pipe types...RCP, CMP, Plastic pipes

Slide 9

KH3

Slide 5 - extra title slide with ability to replace the photos on the left.

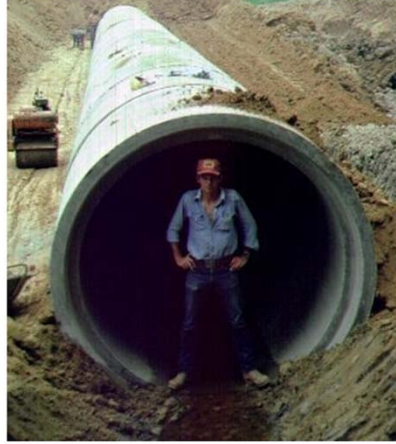
To add a picture: go to menu, Insert, "picture" and "from file". Chose your pciture and then click the "insert" button. The picture will show up somewhere on the middle of the slide. Delete the existing picure on the left that you wanted to replace and then crop the the new image and resize it so that it would roughly fit the area you were trying to fill. The last step is to right click the picture, select "group", "order", and "send to back."That crops the picture and displays it within the space to show the curve. Repeat this with any other pictures you want to change. If you have a different version of PowerPoint, you will have to follow the same steps but the terminology may be different.

NOTE: When you view the slides, sometimes edges of the picture will stick out above and to the left of the slide. This is OK because it will not show up in the slide show or printable form.

Karen Hunter, 8/19/2008

Concrete Pipe Culvert - PII Items in AASHTO...

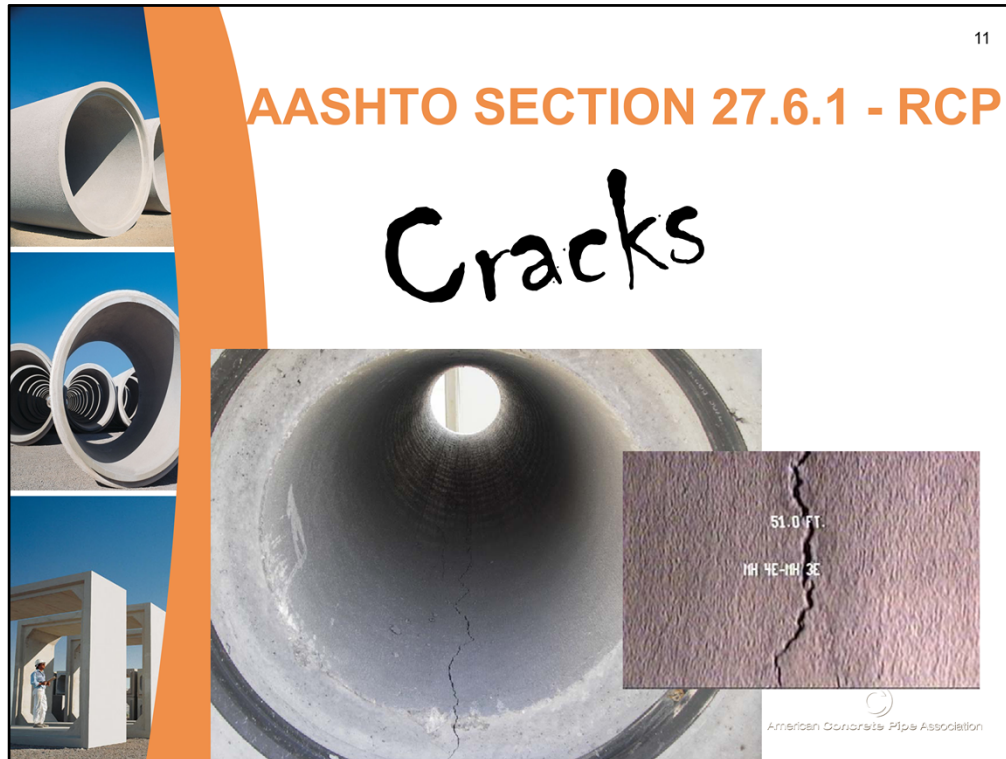
- Misalignment
- Joints
- Cracks
- Spalls
- Slabbing



Slide 10


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The PII sections of Section 27 of AASHTO now discuss the issue to look for and evaluate as part of PII for newly installed RCP. The general topics are listed on the slide in front of you and include Misalignment, Joints, cracks, spalls, and slabbing...





Highlights of the AASHTO RCP PII requirements include:

- No inspection until 30 days after all backfill placed/completed
- Cracks are discussed in good detail and the following are evaluation highlights you need to understand:
 - Cracks less than 0.01" – Acceptable
 - Cracks between 0.01" and up to 0.10" (two dime width) must be evaluated
 - Commentary points out cracks up to 0.10" in a non-corrosive environment (soil/water Ph greater than 5.5) are generally acceptable
 - Cracks larger than 0.10" must be evaluated and be remediated or replaced

In the engineers review/evaluation the crack pattern, location, size (length & width), location are all important considerations to determine severity and or if any remediation is required.

Anyone trying to evaluate cracks in RCP should understand structural design concepts, testing requirements, strength of product (even when cracked), crack patterns and likely causes etc....We can and do provide in-depth training on Proper RCP Evaluation and provide excellent tools for engineer or evaluation team to properly evaluate most all issues that you might encounter in the PII data collected and reported. We fully discuss the evaluation issue and the resources and tools available in the next section of our training.



AASHTO -Thermoplastic Pipes / Culverts (PP, PE, PVC)

- Misalignment
- Joints
- Cracks
- Buckling, Bulging racking
- Deflection

Slide 12

The AASHTO PII requirements include critical items that need evaluation for plastic pipe systems and include;

- Misalignment,
- Joints,
- Cracks,
- Buckling, Bulging, racking
- and Deflection

Notice the last 2 bullets are different items than what you would **not** be looking for in a rigid pipe




Some of the evaluation requirements for (small Diameter/less than 36") plastic pipe would lead anyone to the conclusion that CCTV inspections are a must and certainly some type of shape control check/confirmation is demanded.

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DEFLECTION – AASHTO SECTION 30.5.6

Thermoplastic PIPE

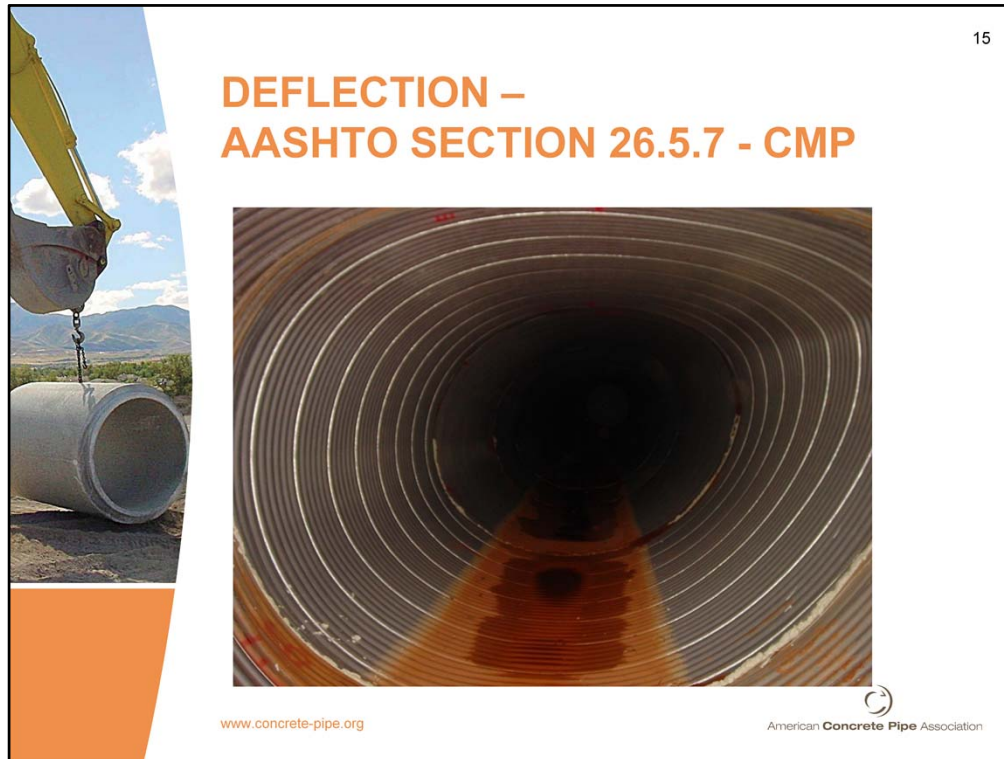


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AASHTO Sect. 30 includes the following evaluation highlights for deflection of plastic pipe: -

- Final inspections no sooner than 30 days after completion of installation and final fill.
- Deflections less than 5% - Are Acceptable
- Deflections more than 5% - are to be Evaluated by Engineer
- Deflections greater than 7.5% - Require Evaluation by Engineer + Remove or Remediation Plan



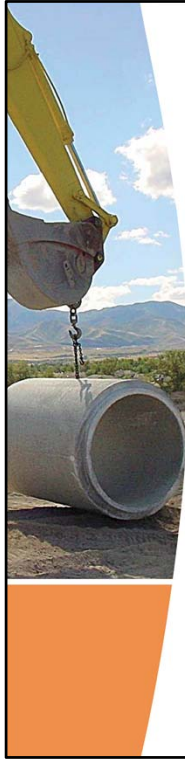
AASHTO SECTION 26 for CMP states also that Final inspections shall be conducted no sooner than 30 days after completion of installation and final fill.
And clarifies that CMP Deflection less than 7.5% - Acceptable
And CMP with Deflection greater than 7.5% - should Evaluated and considered for Removal & Replacement.

Slide 15

KH6

Slide 2 - text page slide, no photo change on left.

Karen Hunter, 8/19/2008



AASHTO Summary


- Some Inspection Items Same for all pipe
 - PII after Fill + 30 Days
 - PII includes misalignment, cracks, joint
- PII Issue Differences:
 - Thermoplastic Pipe + buckling, bulging, racking, deformation
 - CMP + deformation

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AASHTO highlights PII of Plastic Pipe/CMP

- No PII until 30 days after all fill placed over pipe
- Thermoplastic pipe requires evaluation/confirmation of buckling, bulging, racking, deformation/deflection
- CMP requires deformation/deflection checks




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AASHTO REQUIRES Measurements

- Conditions that require Measurement;
 - Crack Width and Location
 - Joint Gap
 - Deflection/Deformation

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Measurement of issues are demanded by AASHTO Specs.:

- Crack widths and location of cracks must be measured for all pipe types using a Video Micrometer (remote CCTV small Dia.), Crack Comparator or leaf gage for pipe with man entry (large dia pipe – 36" and larger)
- Joint gaps must be measured for all pipe types by using a Video Micrometer for small dia pipe, or a Tape measure for pipe allowing man entry
- Deflection/ deformation must be measured for Flexible pipes only by a Laser Deflectometer or Mandrel for small diameter or tape measure or more sophisticated tools to man entry inspections.



Practical Considerations for Spec. Development

- **Clear PII Specifications**
- **Evaluation Criteria**
- **Inspection & Evaluation Team Prepared**
- **Educate Installers**
- **Communicate Process to all Stakeholders**


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Through our work and experience with many State DOT's and municipal owners we have determined there are some key components to implement a successful PII Program


- **Clear PII Specifications**
- **Good and clear Evaluation Criteria should be part of PII Specs. Or be included in Guidance Document**
- **The Inspection and Evaluation Team need to be properly trained and have proper experience & TOOLS needed**
- **The Installers/Contractors need to be educated and informed of PII procedures and evaluation and remediation processes**
- **All stakeholders need to understand PII requirements, the evaluation criteria, review and appeal processes, remediation processes before any program moves forward.**

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PII Specifications and Evaluation Guidelines

- Techniques, Tools, Certifications
- Evaluation Guidelines

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Good PII Specifications must include clearly description of extent of required inspection (10% - AASHTO, 100%, 100% under pvmt & 10% outside pvmt)

Techniques (Remote CCTV + add-ons (small Dia. pipe) or Man access (large Dia pipes) What tools are allowed/required, certification requirements for tools and personnel.













And Evaluation Criteria is a must to go hand in hand or be part of PII Specs. What issues require measurement, what are the threshold/criteria for acceptance, repair, or replace....

In our Experience across the country we have learned how important it is to develop detailed evaluation criteria. It is so very important

For all of the stakeholders to Set and Agree on Expectations before Video Cameras Roll!

Without eval. guidelines no one will know what to do when the first videos and PII reports start rolling in!

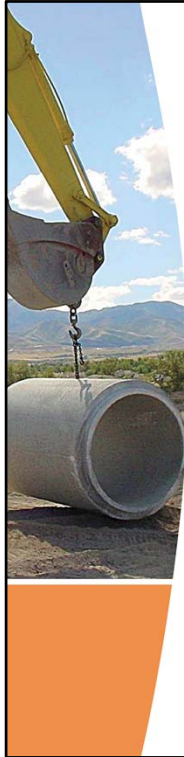
No guidelines will lead to fire drills, increased cost, phone calls from the mayor, governor, developer....etc...

	Tools for Non-Man Entry POST INSTALLATION INSPECTIONS			20
	RCP	HDPE	CMP	
	Visual/Video Inspection			
	Mandrel Testing			
	Laser Defectometer			
	Video Micrometer			
				

This slide covers comments alrerady made about what tools are needed for proper Remote entry PII

- Visual Inspection for Pipe Safe Access (>36")
- CCTV Inspection for small Dia. (36")
 - Add Deflectometer And Direct Measurement Laser for Flex Pipe
 - Add Direct Laser Measurement Tool only for RCP
- Mandrel Inspection – Must use Actual Certified Diameter for pipe installed or Nominal Diameter to calculate deformation
- Must Set criteria for appropriate Quality Acceptance 10% of all pipe installed, include 100% under Pvmt, All Storm Drains, All Pipe greater than 36" Diameter...

Inspection Team Preparation



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Inspection team number one job is to provide clear quantifiable information to allow for proper evaluation...not suggest repairs, evaluate pipeline, they should simply provide information in format as outlined in your specification!

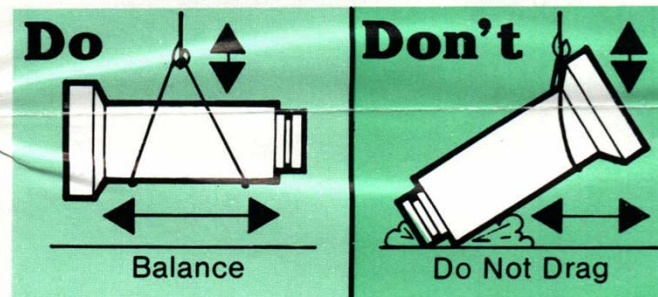
Inspection team should be able to show proof of their training, experience, and knowledge of their inspection tools and equipment. Some States are actually requiring any inspection team to be certified through a state run certification program.

You may want to consider requiring NASSCO PACP Certification – PACP = Pipeline Assessment Certification Program or developing your own Certification program for Inspectors and equipment certification program....

Train Installers

- Handling & Installation Techniques
 - 99% of issues

HANDLING



The success of PII inspection depends heavily of the installer understanding what he/she can do to store, handle, install , and properly protect the installed pipe once it is laid. All of our Installation/Inspection training is dedicated to properly communicating the proper techniques to insure the successful installation of our products. In the next few slides we will discuss some highlights of issues that must be addressed to insure no significant issue are found during the PII process.

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**Chip to You,
Hole in Pipe In Inspection Notes,
Leaking Joint Later!**



REPAIR IT!!!

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Pipe can be damaged during shipment, during unloading process, or after it is stored on the job site.

Most likely the cause of the minor damage on the bell of the pipe above happened when this pipe bumped against another pipe or some hard surface which caused a small section of the bell to “chip” off.

This is repairable but should be completed prior to placing the pipe in ditch,

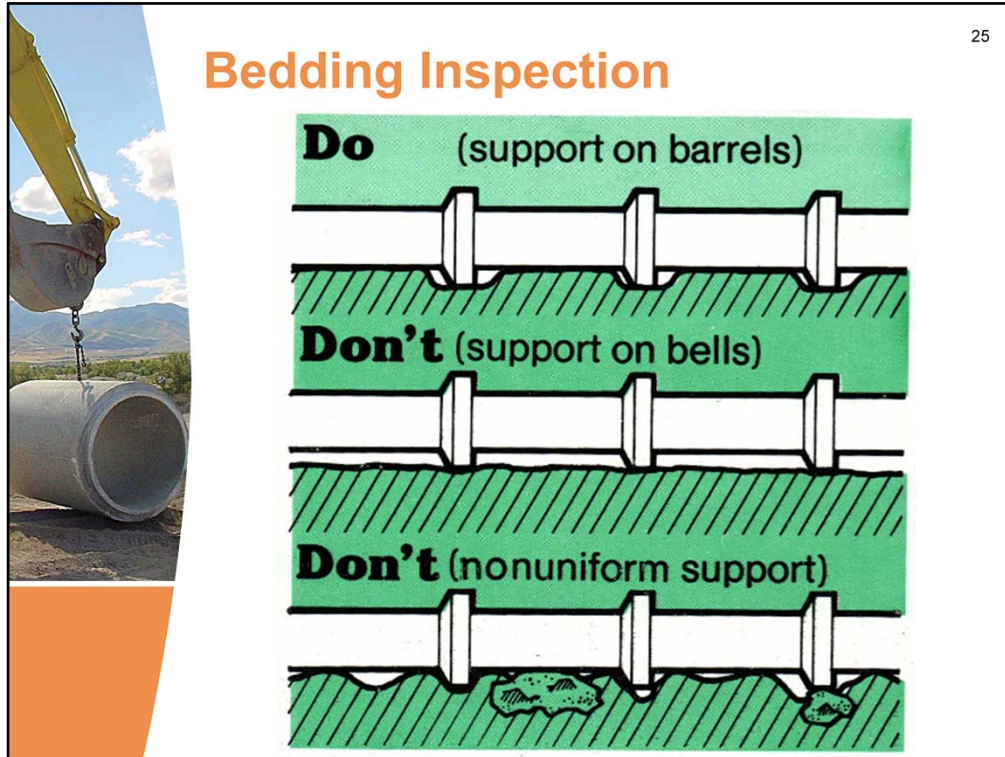


Most critical part of RCP Installation is insuring you have proper foundation for the pipe sysyte!

Foundation is the Box-Springs for Pipe - This is a critical aspect to ensure structurally sound & soil tight installations.

The trench bottom must be stable, give uniform support and have sufficient bearing capacity to maintain pipe alignment and carry the loads.

Check It!



Bedding second most important aspect of RCP pipe installation!

Bedding is "Mattress" for the Pipe...The bedding levels out irregularities in the trench bottom and ensures uniform support of the barrel.

The best bedding material is granular and uniformly graded which spreads well under the pipe haunch.

The bedding directs load through pipe into the foundation.


TOO HARD = EXCESS Stress on Pipe – lead to cracking

Too Soft – joint separation, cracking, sagging,

Bedding sets the "Grade" check it often.

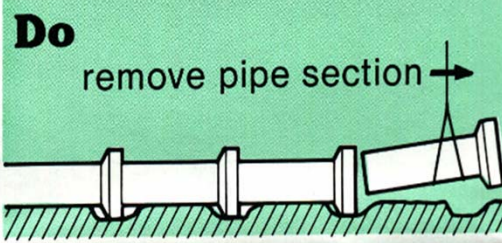
26

Line & Grade




Incorrect

Do
remove pipe section →



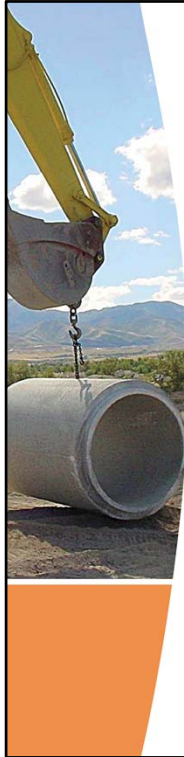
Don't
adjust pipe alignment or
grade with pipe in the
home position.



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If grade not right do not “push” the pipe to grade with track-hoe!
Bells and spigots can be broken with excessive force from equipment!

CONSTRUCTION LOADS!

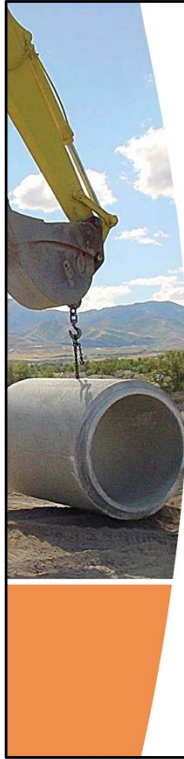


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Construction loads is certainly one of the issues that installers must be aware of. Large loads can be placed upon the pipe with heavy compaction equipment or with large construction equipment when there is little or no cover over the pipe.

RCP should have at least 2' of cover during construction in areas where large equipment is crossing or working in close proximity to the newly installed pipe.



Evaluation Team

- Train, Train, Train
- Differentiate
 - Cosmetic = Non-ISSUES
 - Minor Damage = Note but No Repair
 - Structural Issue = Evaluate Severity and remedy required

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The evaluation team must be properly trained to understand pipe design, structure, how pipe reacts to loads, etc....

Not everything noted in PII inspection report will need remediation or repair.

“Knee Jerk” reaction is to fix anything and everything....that is mistake that cost owner lots of money for no reason

Must set reasonable criteria to establish what issues are cosmetic only and need no repair, establish what issues require evaluation, when an issue is repairable, or when a problem required major repair or removal.



ACPA– Implementation Resources

- PII ePipe - Overview & Summary of State Specifications
- PII Model Specifications
- PII Pipe Evaluation and Repair Guidelines

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ACPA, through our work/experience over the past 5 years with DOT and Municipal owners, has put together a good array of tools to help with implementation or improvement to existing PII program.

In the following slide we will touch on some of those tools and resources.


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PII Inspection Tool #1



Video and Laser Measurement Tools

New Storm Pipe Installation Quality Assurance at Its Best


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An educational document from the American Concrete Pipe Association for users and specifiers


Over the past decade, the deteriorating state of our nation's infrastructure has gained increased attention. Great emphasis has been placed on the aging bridges of our nation's roadways due to several high profile catastrophic failures. Sadly, it took the death of several motorists to spur a public outcry to address the current state of despair of one of our nation's most important infrastructure components.

Our roadway pipe systems demand this very same attention, since they are the "unseen" bridges of our nation's ground transportation systems. While we must address the existing aging system, to maximize the life of future installations we must act now to ensure quality installations are occurring.

It is apparent that we must fully address the importance of:

- Proper **INSPECTION** of all installations,
- Adequate design life,
- Conservative design approaches,
- Complete and stringent reviews of all critical construction components,
- Strong quality assurance programs throughout the construction process, and
- Diligent and proper maintenance of all the components of our roadway infrastructure.


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The ePipe – “Video and Laser Measurement Tools” is a nice overview of the history and current status of PII programs across the US and Canada.

It can be found on our home page in the lower right hand corner – “Whats New” area under ePipes.

Content includes good overview of the benefits of implementation of a PII program, outline of the AASHTO Specs on PII, and DOT requirements from around the country.



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Post Installation Inspection Resources

- Guidelines for PII (Model Specs)
 - “Post Installation Inspection Basics”
 - “Post Installation Inspection Methods, Tools, and Reports”

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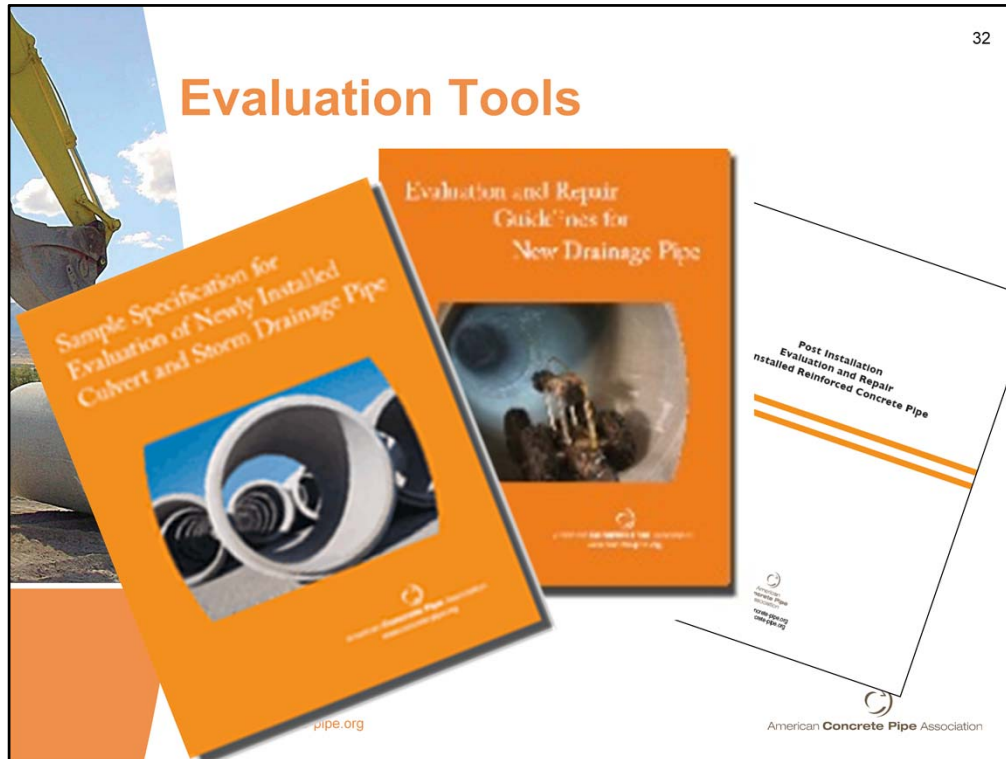
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Find this resource on the ACPA homepage under “What’s New”

We have developed several “model” specs for PII and pipe Evaluation. Our Model specifications are based upon the best of the best components from DOT and municipal specifications from the US.

“Post Installation Inspection Basics” is a short concise specification of PII one might see in on a private project or even a small – non-sophisticated municipality. Light on details but covers the most important aspects of PII.

“Post Installation Inspection Methods, Tools, and Reports” – This model spec. has more detail and covers required techniques, tools, reports, and some major evaluation needs.




We have evaluation guidelines developed for field engineers to allow for quick adjudication of common issues that may be discovered during a pipe inspection. Located on Home Page of ACPA Website

We have cliff notes versions, Readers Digest, and text book versions of evaluation tools available for your use.

All of the information about cracks and joint integrity evaluation as well as other important topics are covered in these documents.

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New National Guidelines Available....AASHTO Const.

- Pipe Inspection and Evaluation Guidelines are available from AASHTO Subcommittee of Construction

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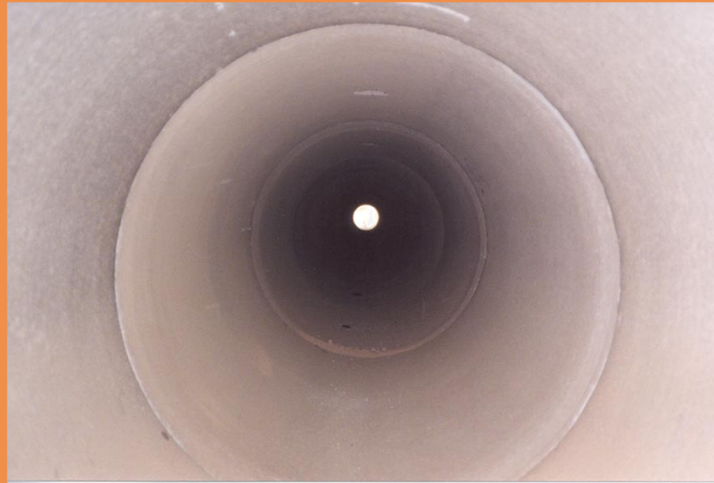
An excellent guideline has been developed for Pipe Inspections and Pipe Evaluation by the AASHTO Subcommittee of Construction.

Covers the criteria for inspection requirements for installed pipe, inspection methods and tools, report requirements, and evaluation and acceptance criteria for all pipe types! This is a great read and a good model for the development of inspection and evaluation specifications.



Our hands on PII Demo's and Plant Tours presents another great option to introduce PII Tools and Procedures, RCP Strength & Quality attributes
 And Provide Knowledge and Tools to obtain Correct Evaluation of Installed RCP
 At these events you would have the opportunity to see up close and personal the PII inspection tools we discussed today and actually see them in action inside of an actual pipe installation. During the plant tour portion you will witness RCP Pipe Production, Structural Testing Procedures, and QC procedures.
 These events also provide a good opportunity to discuss proper evaluation of cracks, joint gaps and other issues that may be of concern to the audience.
 If you are interested in participating in one of these events or want us to consider setting up one in the area please see me after the presentation.

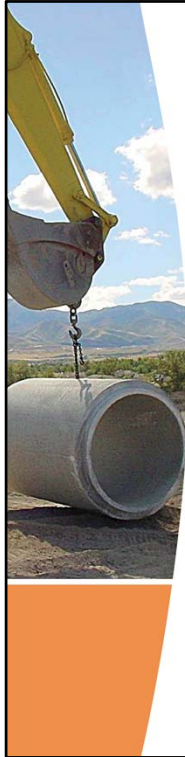
Evaluation Of Installed RCP (An In-Depth Training Class for the Evaluation of Installed RCP)



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I Am All Ears....for your ?'s



Thanks for your kind attention and participation. We hope we have helped you better understand the PII process, tools, and specifications requirements for the successful implementation of a PII program.

I will be glad to take any questions at this time